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(54) **An apparatus to measure properties of a moving sheet with improved standardization means**

(57) Apparatus to measure properties e.g. color, brightness, gloss, of a moving sheet 14, is insensitive to sheet flutter, and comprises housing 22 (to one side of said sheet) containing source 30. The source emits a beam of electromagnetic radiation which impinges on the sheet. The radiation is capable of absorption and reflection by the sheet properties. Collector 38 is located in the housing and receives a portion of the reflected beam. Detector 42 measures the properties. The housing is held at a constant distance from the sheet by a fluid stream from holes 46. Standardization member 50 is held at a constant distance from the other side of the sheet by a fluid stream from tubes 60. The standardization member can comprise rotating part 54, continuously cleaned by member 58 or can be a rotatable member with a plurality of standardization surfaces.

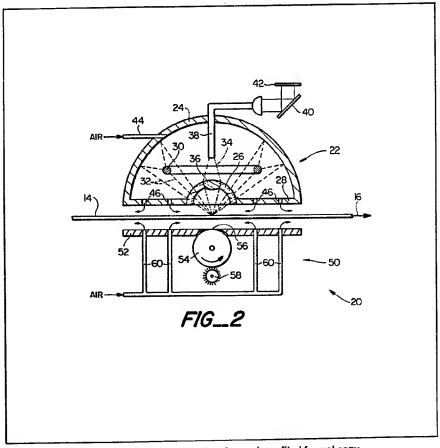

FIG_2

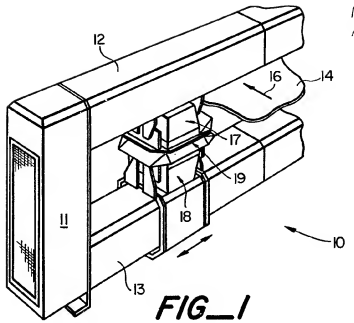

FIG_1

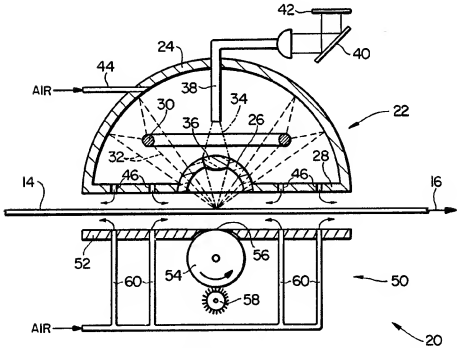

FIG_2

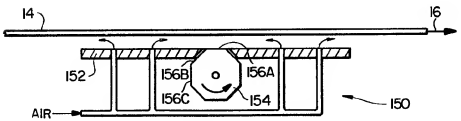

FIG_3

SPECIFICATION

An apparatus to measure select properties of a moving sheet with improved standardization means

The present invention is related to an apparatus for measuring select properties of a moving sheet. More specifically, the present invention is related to an apparatus capable of measuring select properties of a moving sheet, with the apparatus insensitive to the flutter of the sheet and with improved standardization means.

Sensors to measure select properties, such as color, brightness, or gloss, of a moving sheet, are known. One such sensor to measure the color of a moving sheet is manufactured by the MacBeth Division of Kollmorgen Corporation. Typically, such a sensor does not scan, i.e., the sensor is not able to move across the width of the sheet as the sheet is being manufactured. Moreover, such a sensor cannot account for sheet flutter for accurate measurement. These constraints pose two problems: First, the sensor is unable to provide an accurate measurement across the width of the sheet; Secondly, that the sensor cannot account for sheet flutter poses certain limitations in its application of use. Thus, the sensor of the prior art had limitations in its accuracy as well as in its applicability.

An apparatus to measure select properties of a moving sheet with the apparatus insensitive to the flutter of the sheet comprises a source to one side of the sheet. The source is capable of emitting a beam of electromagnetic radiation which is aligned to impinge the sheet. The radiation is selected such that the beam is capable of being absorbed and being reflected by the select properties of the sheet. A collector to said one side of the sheet is capable of receiving a portion of the beam reflected from the sheet. The apparatus is also provided with a detector capable of measuring the select properties of the sheet based on the radiation received by the collector. First means are provided for holding the source and the collector at a constant distance from the sheet. A standardization member is located on the other side of the sheet. Second means are provided for holding the standardization member at a constant distance from the sheet. The standardization means can be a continuously cleaned member or a member with a plurality of standardization surfaces.

One embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

FIGURE 1 is a partial perspective view of a portion of the apparatus for measuring the select properties of a moving sheet, incorporating the present invention;

FIGURE 2 is a schematic representation partially in block diagram form and partially in cross-section of a portion of the apparatus of FIGURE 1 and showing the apparatus of the present invention; and

FIGURE 3 is a plan view of one of the elements of FIGURE 2.

As disclosed in the US Patent No. 3,641,349, a characteristic of a web or sheet material being manufactured by a paper making machine can be measured by mounting sensors and detectors on a carriage. The carriage moves in a cross direction while the sheet material is moving in a machine direction which is perpendicular to the cross direction. FIGURE 1 illustrates a scanner 10 which includes a framework 11 which has a pair of spaced upper and lower parallel beams 12 and 13 which extend laterally of the sheet material or paper indicated at 14 which is being produced by the paper making machine (not shown). The sheet 14 travels through the scanner in the direction as shown by the arrow 16. Upper and lower gauging heads 17 and 18 are provided in the framework 11 and transversely of the sheet 14. Specifically, the sheet 14 travels through a gap 19 provided between the gauging heads 17 and 18. The drive for the gauging heads is such that they can be moved off sheet or in other words, off to the side of the sheet during each direction of travel.

The apparatus 20 of the present invention is as illustrated in FIGURE 2, in which a housing 22 in the upper gauging head 17 is located to one side of the sheet 14. The housing 22 is comprised of a first dome 24 and a second dome 26, both substantially hemispherical in shape, and an annular member 28, which is substantially flat. The inside of the first dome 24 can be a reflective, or diffusive, or specular surface. The second dome 26 is a window. The first dome 24 and the second dome 26 are concentric with the annular member 28 connecting therebetween. The housing 22 is positioned such that the annular member 28 is nearly parallel to the sheet 14 and is in closer proximity to said sheet 14 than the first dome 24 or the second dome 26. A source 30 in the housing 22 is capable of emitting a beam of electromagnetic radiation 32. For measurement of color or brightness, a ring-shaped xenon pulsed tube manufactured and sold by ILC Technology is preferred. The beam 32 from the source 30 is directed to pass through the second dome 26 to impinge the sheet 14 (shown as a dotted line). The light from the source 30 not in direct alignment with the sheet 14 will be reflected from the first dome 24 onto the sheet 14. The radiation from the source 30 is capable of being absorbed and being reflected by the sheet 14. A portion of the radiation reflected from the sheet 14 (the reflected beam 34) is collected by a collector, comprising a lens 36 and a fiber optic 38. The reflected beam 34 follows a path generally shown as a dash-dot-dash line. The lens 36 focuses the reflected beam 34 onto one end of the fiber optic 38 in the housing 22. The lens 36 is located in or near the second dome 26. The fiber optic 38 is passed from the housing 22. At the other end of said fiber optic 38, the reflected beam 34 is aligned to impinge a grating 40 and reflected therefrom onto a detector 42. The grating 40 is used in the measurement of color of the sheet 14, whereby

the color spectrum of the reflected beam 34 is spread out and is incident onto the detector 42. The detector 42 may be a diode array. An air inlet 44 is in the first dome 24. The inlet 44 permits air to enter the housing 22. A plurality of air outlets 46 are located in the annular member 28. The outlets 46 permit air to leave the housing 22 at a constant pressure and to impinge the sheet 14 at a direction substantially perpendicular to the sheet 14.

A standardization member 50 is located on the other side of said sheet 14. The standardization member 50 comprises a flat portion 52 and a rotating member 54, such as a drum, attached thereto. The outer surface 56 of the rotating member 54 is continuously cleaned by a cleaning member 58, such as a brush. The flat portion 52 serves to hold air outlets 60. The air outlets 60 permit air to impinge the sheet 14 at a direction substantially perpendicular to the sheet 14. The air outlets are in substantial linear alignment with the air outlets 46 of the housing 22. The outer surface 56 of the rotating member 54 faces the sheet 14 and has a known reflective response to the incident beam 32. During standardization, i.e., when the sheet 14 is not between the upper and lower gauging heads 17 and 18, and the gauging heads 17 and 18 are to one side of the framework 11, the beam 32 is aligned to impinge the surface 56 of the rotating member 54. The reflected beam 34, reflected from the surface 56, is used to compare it to the known standard. This comparison serves to correct problems such as drift in electronics, lamp aging, and dirt on the lens 36. The cleaning action of the cleaning member 58 serves to remove dirt on the surface 56.

In operation of the apparatus 20 of the present invention, air, under pressure, is introduced into the housing 22 through the inlet 44. The air, under constant pressure, exits from the housing 22 through the outlets 46. The air is directed to impinge the sheet 14 at a direction substantially perpendicular to the sheet 14. Under constant pressure, the air will keep the housing 22 at a constant distance from the sheet 14. Similarly, air under constant pressure is directed from the standardization member 50 to impinge the sheet 14 at a direction substantially perpendicular to the sheet 14 and in linear alignment with the outlets 46 of the first housing 22. The impingement of air on the sheet 14 will maintain the standardization member 50 at a constant distance from the sheet 14. During the operation of the apparatus 20, the source 30 emits a beam of radiation 32 directed to impinge the sheet 14. The reflected beam 34 is collected by lens 36 which is focused onto one end of the fiber optic 38. The other end of the fiber optic 38 is aligned to direct the reflected beam 34 to impinge the detector 42. Various properties of the sheet, such as color or brightness, can be analyzed through the proper selection of the spectral frequency of the beam of radiation of the source 30 and the spectral response of the detector 42.

During standardization the apparatus 20 is moved off sheet, i.e., the sheet 14 is removed. Since the air from the housing 22 will no longer impinge the sheet 14 to "lift" the housing 22 from the sheet, and since the air from the standardization member 50 will also no longer impinge the sheet 14, the housing 22 and the standardization member 50 will move closer to one another until the distance therebetween is substantially the same as the distance between the housing 22 and the sheet 14. In short, the standardization member 50, relative to the housing 22, will move to the position previously located by the sheet 14.

In general, the housing 22 can be of any geometric shape. Since the air must impinge the sheet 14 and "lift" the housing 22, the lighter the housing 22 is the less the amount of air must be expended. The use of the collector, comprising the lens 36 and the fiber optic 38 to gather the reflected beam 34 and to align it to impinge the detector 42, which is not in the housing 22 is to lighten the weight of the housing 22. The housing 22 is only a convenience to hold the source 30 and the collector. The source 30 and the lens 36 and fiber optic 38 may be in any geometric configuration. It should be noted that to further lighten the weight of the housing 22, the source 30 may be located outside the housing 22 with fiber optics connecting the source 30 to the housing 22 to direct the light to impinge the sheet 14. The source 30 can produce any type of electromagnetic radiation, including infrared and ultraviolet. For measurement of color a D65 source (North Sky Daylight) is preferred. (D65 is a standard set by the CIE — Commission Internationale de l'Eclairage.)

In another embodiment of the apparatus 20 of the present invention, FIGURE 3 shows another embodiment of the standardization member 50. The standardization member 150 comprises a flat portion 152 and a rotatable member 154, attached thereto. The rotatable member 154, such as a hexagonal drum, has a plurality of outer standard surfaces thereon, i.e., 156a, 156b, 156c, etc. The flat portion 152 serves to hold air outlets 160. The air outlets 160 permit air to impinge the sheet 14 at a direction substantially perpendicular to the sheet 14. The air outlets are in substantial linear alignment with the air outlets 46 of the housing 22. Each outer surface 156i of the rotatable member 154 can be positioned to face the sheet 14 and has a known reflective response to the incident beam 32. The plurality of outer surfaces 156i serve to move a clean outer surface to face the sheet 14 during standardization in the event one of the outer surfaces of the standardization member 150 itself becomes dirty.

It is thus seen that the advantages of the apparatus 20 of the present invention are: First, the apparatus may be used to scan across the width of the sheet, i.e., the apparatus 20 may be mounted on a carriage as shown in FIGURE 1 and moved across the width of the sheet. Secondly, the apparatus is insensitive to flutter and therefore finds many possible uses of the apparatus. The

apparatus 20 (both the housing 22 as well as the standardization member 50) is each kept at a constant distance from the sheet 14 and thus the apparatus is insensitive to flutter of the sheet, i.e., the unpredictable movement of the sheet 14 along a direction having a component which is perpendicular to the sheet, and finally, a standardization member that is not subject to error that is caused by dirt build-up on the standardization member itself.

CLAIMS

1. An apparatus to measure select properties of a moving sheet, said apparatus, insensitive to the flutter of said sheet, comprising:

a source to one side of said sheet capable of emitting a beam of electromagnetic radiation;

said beam aligned to impinge said sheet;

said radiation selected such that said beam is capable of being absorbed and being reflected by the select properties of said sheet;

a collector to one side of said sheet capable of receiving a portion of said beam reflected from said sheet;

a detector capable of measuring said select properties of said sheet based upon said radiation received by said collector;

first means for holding said source and said collector at a constant distance from said sheet;

a rotating member with cleaning means in continuous contact with said member to other side of said sheet; and

second means for holding said rotating member at a constant distance from said sheet.

2. The apparatus of Claim 1 wherein said source and said collector are in a housing.

3. The apparatus of Claim 2 wherein said first means is a stream of fluid from said housing directed to impinge said sheet along a direction substantially perpendicular to said sheet.

4. The apparatus of Claim 3 wherein said second means is a stream of fluid from said member directed to impinge said sheet along a direction substantially perpendicular to said sheet and in linear alignment with said first means.

5. The apparatus of Claim 4 wherein said collector is a lens and a fiber optic, wherein said lens is positioned to focus a portion of said beam reflected from said sheet onto one end of said fiber optic, and said other end of said fiber optic aligned to impinge said detector.

6. An apparatus to measure select properties of a moving sheet, said apparatus, insensitive to the flutter of said sheet, comprising:

a source to one side of said sheet capable of emitting a beam of electromagnetic radiation;

said beam aligned to impinge said sheet;

said radiation selected such that said beam is capable of being absorbed and being reflected by the select properties of said sheet;

a collector to one side of said sheet capable of receiving a portion of said beam reflected from said sheet;

a detector capable of measuring said select properties of said sheet based upon said radiation received by said collector;

first means for holding said source and said collector at a constant distance from said sheet;

a rotatable member with a plurality of standard surfaces to other side of said sheet; and

second means for holding said rotatable member at a constant distance from said sheet.

7. The apparatus of Claim 6 wherein said source and said collector are in a housing.

8. The apparatus of Claim 7 wherein said first means is a stream of fluid from said housing directed to impinge said sheet along a direction substantially perpendicular to said sheet.

9. The apparatus of Claim 8 wherein said second means is a stream of fluid from said member directed to impinge said sheet along a direction substantially perpendicular to said sheet and in linear alignment with said first means.

10. The apparatus of Claim 9 wherein said collector is a lens and a fiber optic, wherein said lens is positioned to focus a portion of said beam reflected from said sheet onto one end of said fiber optic, and said other end of said fiber optic aligned to impinge said detector.

11. An apparatus to measure select properties of a moving sheet substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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